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METEOROLOGY.

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THE WEATHER MAP

AND

THE "RAIN-MAKERS."

THE FACTORS NECESSARY TO PRODUCE RAIN, MAN'S ATTEMPT TO RIVAL THEM, AND A FEW GENERAL REMARKS ON OUR WEATHER SYSTEM, BASED ON FACTS FROM THE WEATHER MAP.

BY

ISAAC P. NOYES.

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INTRODUCTION.

Facts and not mere theories herein prevail; indeed, there is very little space alloted to theories, there being facts enough to engage the attention of the reader. In all such works, however, theories are essential and even necessary in order to supply the connecting links where facts are for the time being wanting. So it is not well to speak lightly of them, excepting where too much prominence is given to them to the neglect or development of facts. In all departments of life facts are all important. Theories for a time, at least, must necessarily have a place, in many, if not in all, of the departments of science; but they are, after all, only a temporary substitute, and as the lines of facts are advanced, theories are relegated to the rear. The modern world has a great regard and even veneration for facts. He who discovers a fact from the recesses of nature, comprehends its value and sets forth its important bearing upon the autonomy of creation, confers a lasting blessing upon mankind. As earnestly as the ancient world sought for the "Philosopher's Stone"

and other chimerical institutions, the modern world seeks for facts. As a medium for establishing facts in the important department of meteorology, the world has never produced, nor even approximated, anything that would compare with the Weather Map. It is, indeed, far beyond anything else that the world has seen or even dreamed of. For this reason it should be appreciated, for it deals in facts; and such facts as are necessarily powerful factors in disseminating truth and enlightening the world.

I. P. N.

WHAT is termed man's power over the forces of nature has led many to think and to claim that rain can be produced by man at will. Strictly speaking, man has no power over the forces of nature. Sure he can take many a hint from the physical world, and, patterning after nature, as in the mechanical and chemical departments, produce many wonderful results. But, after all, he merely imitates, and very crudely at that, some of the minor forces in nature. He never yet has attained, or even approximated, the power of creation. Creation is a mystery to us, ever has been, and, we believe, ever will be. There are two classes of men who do not attempt this; one through too much ignorance to know anything about the forces of nature, and who, therefore, have no thought or desire to compete with so all-mysterious and powerful an element, and the other, who have too much wisdom and good sense to attempt it. The latter class do, however, master all the details that it is possible for man to master, and turn the same to account for the best interests of mankind.

In addition to these two classes is a third class, having a limited amount of practical wisdom, combined with much imagination. This class often seem to think that man has made further advancement than he really has. What man has done impresses them with the idea that he can do more, and that it is only a question of time when the real mysteries of nature will be revealed and reproduced. But this is a poor line of argument. Perhaps though it has not been without its advantages, for it often requires such a stimulus to force some men on to accomplish even what they do. But for it they would be content to be as stone-lilies. They are like men who start out on a long journey to discover some "Atlantis" or "Philosopher's Stone." But for these wild excelsior dreams they would not have the ambition or inclination to hardly go beyond the sight of their own church spire. The impractical dream takes possession of them, and then sometimes by the way they loiter and really discover something of value. But the higher grade of man wants no such incentive. He goes out in search of treasure that will

benefit the world. The incentive may sometimes be governed by mere ambition to excel rather than for the purpose of general good to his fellow-men. Still he is in search for treasure as he goes along, and is going along for that purpose, and is not inspired chiefly to attain something which his better sense has taught him is beyond his reach. The class who seem to think they can accomplish everything, and compete with nature in all her parts, at present seem to be carried away with the idea that they can compete with nature in the line of producing rain at will. They do not seem to have the least idea of the magnitude of the forces whereby nature produces this result. They seem to think that there is enough moisture always present in the upper strata of the atmosphere to produce rain, and all they have to do is to contrive some mechanical device whereby they can tap this great reservoir, as one might tap some high cistern, and down the water will come in copious showers. Before the age of discovery it was not unnatural that men should believe in and discuss all manner of absurd notions as to the formation of the earth. But when the discoverers of the world had obtained some exact knowledge of the earth, and thereby made geography an intelligent study, such absurd theories and notions naturally became obsolete.

In ancient times theory and sentiment ruled the world, but the modern world, while it still indulges in these things, has a greater regard and inspiration for facts. Facts is what the modern world is seeking for; and as earnestly as the ancient world sought for the philosopher's stone and other chimerical institutions, the modern world seeks for facts. Theory is not relegated to oblivion, but to its proper place. It is no longer the superstructure, but only the mere scaffold, ready to be taken down the moment the walls are reared, and the structure walls built upon a solid foundation. Practically speaking, even twenty years ago the world knew little or nothing as to that portion of the physical condition of our atmosphere, or that portion of creation that lies between the solid earth and the heavens that are above the earth. Little wisdom is even to be obtained from the physical geographies of to-day, for the reason that they are based on imperfect information and theories of an age when the facts had not been brought to light. It may be asked, why could not all the wise

men of the world, up to the present generation, advance in the line of meteorology, as well as in many of the kindred sciences? For about the same reason that they could not sustain themselves in the air without a support. Build the pedestal under them and give them something to stand on, then it becomes quite an easy matter. As one man is dependent upon another, so is one department of science dependent upon another. Meteorology could make no material progress until electricity was so far developed as to give us the telegraphic system. There are men who continually like to boast of the past, and endeavor to make the world believe that everything we have in the present was known to the ancients. If the ancients had any knowledge of electricity, its application to the telegraph, and from the telegraph on to meteorology, we have not as yet heard of it, and had they had these advantages we would have had ample evidences of them in the records of the past.

Meteorology depended upon the development of the telegraphic system through the subtile power of electricity. By this means we are enabled to send the results of all the observations taken over an unlimited territory at the same moment of time, simultaneously and instantly, to some common centre, where they are tabulated and mapped, whereby the weather conditions of this extended country are, on the weather map, daily spread before our eyes. By these modern contrivances we are enabled as it were to lift ourselves up above the surface of the earth, and to take in at a glance the meteorological conditions of a vast extent of country; and in time, when this system is spread over the whole world, as we hope it will be, to see and familiarize ourselves with the meteorological conditions of the entire earth. By this system we have obtained a wonderful fund of information as to the atmosphere of our globe, information never before dreamed of. To be sure, even before the development and perfection of this system, we had crude information of the existence of changes in the conditions of the atmosphere; that at times a condition of high or low barometer would be over a certain locality, but we knew nothing about the changes and laws thereof. Even the present physical geographies are full of absurd and false information. Little or nothing even was known of the cause of a storm. Precipitation, according to this wisdom (?), is due to mountain

ranges; and it is therein all pictured out, how the winds bring in the clouds from the oceans and the seas, and in their passing over a mountain range the clouds meet with another condition of atmosphere, and is thereby precipitated in the form of rain or snow (!) They give no information as to what causes these winds to blow as they do, or why the character of the precipitation should be in the form of rain or snow, or how it is that areas of plains, a thousand miles or more distant from these mountain ranges, get full as much, if not more, rain or snow than the districts in the immediate neighborhood of the mountains. Indeed, the physical geographies of to-day furnish very little information of value in this department. By the weather map we obtain all the important facts, without which we would still be in the dark as to the conditions of that portion of the universe lying between the earth and the heavens, which we term our atmosphere. By the map we understand as never before the agency whereby these phenomena are wrought. The first fact in the case is the Sun; the next a planet, like our Earth, composed of land and water. With all land and no water, we would have no atmosphere. We would be what we believe the Moon to be, an atmosphereless body. So really it is the presence of the element we term "water" that gives us our atmosphere, whereby life is a property of this and similar globes. Take the water away and our atmosphere would be gone, and our globe would become like the Moon, a lifeless orb floating in space, in direct contact with the subtile ether that lies beyond the confines of our atmosphere. The next step in order is to have the heat of the Sun active on the surface of our planet, whereby the rotation of the planet is caused, and locality after locality of it exposed to the direct action of the Sun. The surface of the Earth thereby becomes heated; some spots are more favorable for receiving heat than others. Here the Sun's power becomes concentrated. Heat has an affinity for heat.

Day after day this power is active, more or less, over the whole earth, but where the rays of the sun are the most direct, there this power is the greatest. But over the greater portion of the globe, at least, there is sufficient heat for evaporation, and thereby clouds are formed. Drops of water are very infinitesimal things in themselves; but we see that the rivers and oceans of the world are made up of them. So with this evaporation; it is even more infinitesimal than the drops of water, but it is there, wherever

there is heat, and the process of heat combining with the water and forming its little balloons goes on, almost, if not quite, imperceptibly. These little balloons ascend higher and higher above the surface of the earth. They have no power of direction in themselves; but now comes in the factor which we term the *wind*.* And the wind is produced by the agency of concentrated heat. This concentrated heat rarifies the air, or attempts to make a vacuum, but the surrounding air rushes in to fill the space. The clouds now being an undivided part of the atmosphere, and one with it, are carried along with it towards the rarified spot, which is designated as the area of low barometer. These clouds, as they gather in deep and massive columns, necessarily shut off the direct rays of the sun, so that the sun has not the power at the original point that it had at first. Then more, the earth is, the while, turning towards what we term the east. A thousand or two thousand miles further to the westward another area of low barometer is developed, and the clouds that are within its influence are brought to that point. Between these areas of low barometer is the area of high barometer. There is only so much atmosphere on the globe. None of it is taken away or consumed.

Possibly there may be some curiosity as to the extent of these "HIGHS" and "LOWS." The circle that includes the lowest pressure may not be more than a hundred miles in extent, and may even be less. Outside of this circle will be other and other and larger and larger circles, each indicating a greater and greater pressure until the lines reach the centre of the "HIGH," where the highest pressure will be, covering an area of more or less extent from a circle no larger than that of the inner circle of "LOW" to an extended circle of many hundreds of miles in diameter. The lines of these circles may be twenty-five miles apart, or they may be many hundreds of miles apart. All depends upon the intensity of the atmospheric pressure. On an average, across the area of the United States, from east to west, there will be, say, a "LOW" in the east, a "HIGH" in the centre,

* I am well aware that the gentlemen who have committed themselves to the support of the so-called dust theory assert that this idea is exploded, and that they would have us believe that dust is the all-important thing in meteorology. According to their ideas, dust is the nucleus of all moisture in the atmosphere, from fog to heavy rain. The old showman said: "You pay your money; you take your choice."

with another "LOW" in the west. The variety is infinite, and can only be fully understood by a daily consultation of the map.

Where the "LOWS" are, there the atmosphere ascends until it meets the cooler strata of air above; then it descends and builds up the "HIGHS" between the "LOWS." For this reason the "HIGH" is, as a whole, a cool, dry factor, though the upper currents, right from the overflowing "LOW," may, for a short time, be comparatively mild, and under favorable conditions they may even move quite a distance in a horizontal direction, as a surface wind, towards the very "LOW" from which they came. But the general condition of the atmosphere at "HIGH" is to rapidly lose its heat. So the "HIGH" is, as a whole, a cool, dry factor, and the "LOWS" are wet factors, and warm or cold in proportion to their latitude. The wind on the surface of the earth, for a mile or two or more in height, is from the area of high barometer to that of the "LOW." Above the earth the movement is reversed, and is from the "LOW" to the "HIGH"; and this accounts for the movement of those light clouds sometimes seen moving in an opposite direction from what may be termed the surface clouds. By this means nature economizes her atmosphere, daily and hourly purifying it and keeping it in constant motion.

This ascending and descending movement of the atmosphere will readily account for, and undoubtedly is the cause of, that peculiar condition known as the "Chinook," or "Foehn," which is a warm, dry air, more noticeable in winter than in summer, because of the contrast of temperature. The warm airs, ascending from the "LOW" centres, descend at the "HIGH," and for the time being are warm and dry. There is no power in a cold mountain to heat any airs passing over it or down its sides. Neither can such airs be heated by any "compression," even though such conditions were present. It is all the result of airs that have been gathered and heated at the centre "LOW," descending to build up the centre "HIGH."

Independent of all this, the seasons of the year have their part to perform. In what we term the summer months of the different hemispheres there is a more general heat; for this reason, during these warmer months, on the whole, there can be and is less concentration of heat than during the colder months of the year. The activity of tornadoes would seem to contradict this, because

of the heat power necessary to cause them, but when we come to understand that department they furnish no conflicting evidence. In the cooler months of the year the contrast is far greater. This is indicated on the weather map by what are termed the *gradients*.

In the summer time the *gradients* will be far apart. The centre of the "LOW" will seldom be lower than 29.9, while the centre of the "HIGH" will be 30.1 or 30.2; *i. e.*, only two or three-tenths of an inch difference between them; while in the winter months the "LOWS" will frequently be 29.4 and the "HIGHS" 30.7, an inch and three-tenths difference; and sometimes the "LOW" will be 28.9 and the "HIGH" 31.1, or two and two-tenths difference! This excessive difference does not often occur, but the difference between the pressure of summer and winter is very marked. There seems to be an impression that "LOW," or the area of low barometer, is a factor that produces a certain effect, as a chemical reagent might. While "LOW" is the agent of the storm, it is rather a centre towards which the currents of winds are directed, and these winds bring along whatever clouds there may be within their influence. But it often happens, particularly during the warmer months, that the centre of the "LOW" is so distant and of so little power that the clouds "drop their fatness" long before they even reach the outer lines of "LOW." During the warmer months the "LOWS" seem to travel on higher lines of latitude, their intensity being only about 29.9, while the "HIGHS" are spread over the southern territory with an intensity of about 30.1 or 30.2. The result of this is to neutralize the temperature of the two sections. The north country is kept warm by the south winds, and the presence of the "HIGH" in the Southern States tempers the heat there.

Such being the case, what are termed "locals" are much more frequent in the warmer than in the cooler months of the year. They are termed "locals," for the reason that they are little substorms taking place here and there quite a distance from and to the south of the centre of the "LOW." In warm weather evaporation is much more rapid than during the cooler months. In the cooler months the precipitation takes place most of the time in and about the centre, whereby a tract of country is covered three hundred, five hundred, and even a thousand miles in extent.

Nature in many, if not in all, of her departments spurns similarity. No two storms are alike. There are general storms in

summer and "locals" in winter; but the general storm is more characteristic of winter, while the "local" is more peculiar to the summer. These storm centres all travel on general lines from the west towards the east. They enter the United States at four general points: the extreme northwest, at the head of the Gulf of California, through Mexico and Texas, and occasionally one from the West Indies, advancing along the Atlantic coast. Their several courses all trend towards the northeast. So no matter where the storm centre "LOW" enters the area of the United States, it passes off, on its course around the world, from some point in the northeast, between northern Massachusetts and the Gulf of St. Lawrence.

The more we study the weather map the more the beauty of the grand system of watering the earth is revealed to us. But for the action of the factors "HIGH" and "LOW" our earth would not be the paradise it is. Sure some other system might have been created, but then we could say the same as to all the departments of nature. We know nothing of the resources of the Creator. We can but have the highest admiration for the wonderful systems we see around us; and while we claim none as superior to the rest, we do claim this department as the peer of any other.

Were there no "HIGHS" nor "LOWS," we cannot see how the earth would be near as beautiful and productive as it is with them. A fog-like condition would prevail all the time; there would be no storms nor even fair weather, no stars visible at night, so the science of astronomy would never have been known. All above us would be a canopy of impenetrable mist, growing a little heavier and heavier, until it resulted in a dreary drizzle, with a perpetual repetition thereof. The Sun, the Moon, and the stars might shine in all their glory; the morning sun might touch with resplendent color the higher mountain tops, and the departing sun at eve might linger with glorious beauty on the higher elevations of the earth, but none of this beauty, as now, would be visible to us—our whole globe would be enveloped in a perpetual mist or fog. Other worlds could not discern us among the planets of the universe, at least to any advantage, and other worlds would be as nothing to us. The poets have lingered on many things, but, to our knowledge, they have not pictured the condition of

our earth without the presence of these active meteorological factors which we term "HIGH" and "LOW."

The mission of "LOW" is to concentrate the clouds at certain points, and to keep ever on the move, on general lines, around the world, from the west towards the east, distributing along its pathway the water gathered from the oceans, seas, rivers, and lakes of the world, over the surface of the earth, for the direct and indirect benefit of man.

The mission of "HIGH" is to clear the atmosphere, thereby giving the Sun a better chance for a more direct action upon the surface of the earth. This direct action of the Sun is of inestimable value to man, and the glory and beauty it adds to the landscape at early morn and early eve affords him infinite pleasure and delight.

So it would seem becoming in us to have much veneration for this grand system, which not only makes our globe habitable, but adds to it a glory and beauty that in all ages has been an inspiration which has lifted the mind of man to the highest appreciation of the works of creation.

Herein I have given a general sketch of the meteorological conditions of the Earth. It will be seen that the "locals" are, as a rule, warm weather storms. It is impossible to locate them with exactness. All we can say is, that they will take place within a certain extended area. On Monday, say, it may take place at "A;" on Tuesday, while it will be within the same general area, it will be pleasant at "A," and the "local" will take place forty or fifty miles from "A," at "B." From this it will be seen that nature requires a large area in which to work.

There must be the material, water, and the heat power of the Sun acting thereon. All portions of the atmosphere are not at all times equally supplied with the necessary moisture. It is quite amusing to read of the descriptions of the atmosphere by those who are so earnest in their support of man's power to produce rain at will. If they would familiarize themselves with the weather map and compare notes they would readily see how nicely they have been describing the forerunner to the conditions that produce the summer "local."

Some claim that it is the noise or concussion from the heavy artillery firing, and yet they cite Plutarch as authority in the

ancient world when battles were fought with bows and arrows, swords and catapults, wherein there could have been no noise beyond the voices of the combatants. So if a few thousand men could produce rain in those ancient days by halloaing certainly a like number could to-day, and this method might be quite as cheap as that of expensive fireworks shot off in the sky. The winter of 1864 and '65 I was in the Army of the Potomac, near Petersburg, where there was cannonading almost every night. If there had been any such power in this artillery firing, certainly there should have been some evidence of it in such heavy firing as took place there.

These men are ready with their statistics as to the great number of battles that were followed by rain, but their statistics are quite silent as to the meteorological conditions of the periods of which they write, though in some minor yet important details of description they have given themselves away. For example, one of these writers refers to the condition of the atmosphere on the morning of the 17th of June, prior to the battle of Waterloo. Surely up to this time there had been no artillery firing; the battle had not begun. Yet, according to the evidence, even of this very writer, the forerunner of the summer "local" was already present over this territory, and in a few hours it would have developed whether cannonading was present or not, for the simple reason that these conditions are a part of the summer "local." No Fourth of July firing nor the firing of a battle would or could produce these effects. The cause is not local, but hundreds of miles away.

As to the statistics these parties offer, they are about as valuable as the statistics offered as to the supposed influence of the Moon on the weather. There are probably more people who still believe in the Moon's influence than who believe in the concussion influence as applied to rain. On the same night in one locality people will think the clouds are driven away and thereby the rain averted, while less than a hundred miles distant the same class of people will believe that the storm in their locality is induced by the Moon. A strange kind of Moon that will have one influence in one place, and as many different kinds of influences as there are varieties of weather, all in one night! The weather map has proved beyond doubt that the Moon has no influence upon the weather; and more, that it is absurd to hold any such notions in

regard to our earth's satellite. As to battles and their supposed influence, they have about as much to do with the cause of rain-fall as rain-fall has to do with them, if anything less. The simple solution of the matter is that the great majority of the battles of the world take place at that season of the year when "locals" are in order; that is, during the warmer months of the year, when the areas of low barometer predominated on a high line of latitude, and when there is little difference between the scale of the "HIGH" and the "LOW," and the *gradients* are far apart.

Before the "Rain-makers" went to their work in Texas, (in the summer of 1891,) in a communication to the Washington *Star*, I told them how to try their scheme so as to satisfy the intelligent people of the world, and how to make it an apparent success to the vulgar crowd. In order to make an experiment that would be satisfactory to the intelligent masses, it was suggested that they try the same in the centre of an extensive and high-grade "HIGH." Could they produce rain under those atmospheric conditions then their scheme might be worth considering; but to attempt it within the confines of a "LOW" was most absurd, for thereby they could obtain most any result, and at times, from their point of view, an apparently most favorable one. Some of the advocates of this idea have admitted that the *conditions must be favorable* for the success of the experiment (!) Certainly they must, and the favorable conditions are as herein explained.

But, says the enthusiasts for this side, we have already accomplished the feat. Possibly they think they have. In that a rain-fall was coincident with their experiment does not prove that their experiment had aught to do with it. If as men they are desirous of making such a test as will satisfy the scientific world, let them, as herein suggested, try their experiment when the atmospheric conditions are not favorable for "locals." If the thing can be worked in one locality surely it can be in another. Nature is not unlike herself in different localities. So far as general laws are concerned, she is the same the world over. In details she produces a great variety, but in her general make-up her varieties are the same. There are no two oaks, or other trees, alike in detail; yet all oaks of a class are alike, and one would never be mistaken for another. There was no need of going off to any out-of-way place where the weather bureau stations are few and far apart. If there is anything of value in such experi-

ments; if man has any such power over nature, which really amounts to rivaling the Creator and making something out of nothing; if man has this power in the department of meteorology, then surely he should have it in all the other departments, and neither time nor place should hamper him, and he should be as ready to prove himself in one place and time as at another, and should be equally ready to try his hand under unfavorable as well as under favorable circumstances. Indeed, the very fact of seeking favorable circumstances should condemn him. But there is an attempt to make it appear that these "rain-makers" went to an unfavorable country. It may be that that portion of Texas suffers from drought, but nevertheless it is within a circle where "locals" are in order during the warmer months of the year. Let them try their experiments somewhere in the centre of the United States, say somewhere between Ohio and Nebraska, when there is a good thirty and seven-tenths "HIGH" present, then let us see what the result will be.

But the public will never fully comprehend this, nor the claims of these men, what it is possible and what it is not possible to do, until they familiarize themselves with the only source of evidence, the weather map, that throws light upon this important branch of physical science. This map reveals to us the conditions of the atmosphere over the whole country, and lifts man above his mere local surroundings, and extends his horizon in the United States to a distance of some three thousand miles.

If we want information as to future meteorological conditions, the weather map is now easy of access, and if we will daily devote a little of our spare time to it we may readily learn to comprehend the signs thereon displayed, and in a comparatively short time become so expert that a mere glance will reveal to us the secrets of nature in this department. But we must take nature as we find her, and consult her through the medium of common sense rather than through any occult channels. We must learn to discover the movements of the "HIGHS" and "LOWS;" to note their location, their direction, and their intensities; to familiarize ourselves with the isothermal lines (or lines of equal temperature indicated on this map by dotted lines) and the "isobars," or lines of equal baromic pressure, (indicated on the map by heavy lines, drawn through the points of equal pressure.) For example, if the centre of "LOW" is 29.4, the line of 29.4 will connect all

the points, including this pressure. For every tenth of an inch pressure there will be a line, 29.4, 29.5, 29.6, and so on up to 30.0, which may be termed the border line between the "HIGH" and the "LOW." Then as we approach the centre of the "HIGH" the figures will be 30.1, 30.2, 30.3, and so on up to the highest "HIGH," which in summer is rarely over 30.3, while in winter it frequently reaches 30.6, and sometimes 31.1. The isobars are termed the *gradients*. In summer these *gradients*, with rare exceptions, are far apart, while in the winter the prevailing condition is for them to be near together. A little experience with the weather map will readily make this very clear to an observer. Another interesting and important point to consider is the direction of the *isothermal* or dotted lines, indicating the points of equal temperature. As the area of low barometer, or "LOW," as it is technically called, is the agent whereby the wind is produced, wherever this agent is located there will the winds be centered. If "LOW" is in the north, then it will be relatively warm there on account of the south winds thereby engendered; if in the south, it will bring down the winds from the north, which are necessarily the cold winds of the earth. If a "LOW" is moving on a high line, say in the neighborhood of the Gulf of St. Lawrence, and the "HIGH" is quite far to the south, say centered over Texas, then the isothermal lines will, in the eastern half of the United States, run from the southwest to the northeast. At times there will be a north "LOW" in the east and another in the west, one centered over the mouth of the St. Lawrence, the other in the extreme northwest, over the State of Washington, with a central southern "HIGH." In this case the isothermal lines will run, in horseshoe form, from the extreme northwest down to the Gulf, and then up in a northeast direction to the mouth of the St. Lawrence. In other words, it will be as warm in the extreme northeast and northwest as on the shores of the Gulf, or it will be as cold on the shores of the Gulf of Mexico as on the shores of the Gulf of St. Lawrence, on the northeast Atlantic seaboard, and as on the shores of Puget Sound on the northwest Pacific Coast.

North winds are necessarily cold and south winds warm; the temperature of the atmosphere is more or less governed by the direction of the winds, yet a north wind is sometimes quite mild, while a south wind is at times quite cold. Before the age of the

weather map this could not have been explained, but to-day, by the aid of the map, it is made exceedingly clear. But it may be asked, why should the winds from the "HIGH" be relatively cool, and why should the north "LOW" produce a high degree of temperature and the south "LOW" a low degree of temperature? The north "LOW" produces a high degree of temperature for the simple reason that thereby south winds are engendered, and south winds, from their very nature, being from the equatorial regions, must be warm, and the north "LOW" takes them far to the north; while with the "LOW," in the south, the north winds prevail, and they being from the cold north country must be cold. The area of "HIGH" is a cool factor, for the reason that the winds are always from the "HIGH;" so there is no opportunity for it to become heated. The "HIGHS" lie between the "LOWS," and are built up by the air overflowing from the "LOWS" far above the surface of the earth, whereby these airs from the "LOWS" are cooled. There is no warm air along the surface of the earth flowing towards the "HIGHS" to heat them. They are necessarily made up of cool and dry airs. Hence, the "HIGHS" are cool, dry factors. When there has been a prevalence of north "LOWS," and the airs in that region have become heated, then a moderate "HIGH" passes over the north country, and a moderate "LOW" is in the south, the north winds will be relatively mild; while if there is a positive "HIGH" in the south, say with a pressure of 30.6 over the cotton States, the winds from the south will be quite cold.

The tornado or cyclone—call it what we will—is the summer "local" intensified and extended. In regard to the "local" we can indicate the general territory over which it will take place, as during the thunder storm we can, in a general manner, indicate the lightning, but we cannot say what particular spot will be visited. All storms proceed from the agent "LOW." When "LOW" is quite extensive and intense, producing such storms as more frequently happen in southern or equatorial latitudes and during the warmer months of the year along the Southern coasts, they are generally designated by the term "hurricane." But where the period of time covered is measured by the fraction of an hour, and sometimes only by a few minutes, and the intensity is great, they are called tornadoes or cyclones. If comparatively mild, then they are known as "local." But no matter what may

be the name, "LOW" is the agent whereby the phenomenon is caused. In order to produce the "local" tornado or cyclone the face of nature must be prepared for it, first, by a series of north "LOWS" or relatively north "LOWS," whereby the necessary amount of heat is produced; then comes along another "LOW," moving on a general line towards the north "LOW." The "local" tornado or cyclone will take place somewhere in the track of this latter "LOW." The real cause of the phenomenon is hundreds of miles away rather than in the immediate neighborhood of where the destruction takes place. It is nature's attempt to produce a vacuum in open space; but "just before she does she doesn't," well represents the action, or it may be represented by the drawing of a stick rapidly through water. For an instant the water is piled up, forming a trough, which the surrounding waters following the stick soon rush in and fill. In this connection, more particularly in the region of bodies of water, as on the sea or near inland waters, the "water-spout" frequently forms an accompaniment of the fierce storm.

The "water-spout" is nothing more nor less than heavy cloud formations that are being carried furiously along by this narrow current in the wake of the "LOW." The clouds are suspended moisture that the winds are wafting toward "LOW." When the conditions become very intense, the clouds, as well as other surroundings, partake of the influences in such violent action. They are carried rapidly forward; the moisture in them is only prevented from immediate precipitation by the swiftness of their motion. As it is, the lower sides by the force of gravity or mere weight reach down into a point, and even attract the water over which they are passing. Their darkness of color is due to the concentration of the watery mass. Thus moving along a narrow channel a rotary motion is developed, or a motion around their axis as well as a forward motion toward the distant "LOW." When one of these tornado clouds bursts, immense quantities of water are liberated all at once, and often do much damage.

Another fierce wind is known by the name of the "blizzard." While the tornado or cyclone is more peculiar to the warmer months of the year, the "blizzard" belongs more especially to the colder months. Though nature in her meteorological conditions seems to spurn regularity of action, so at times we will have the tornado in the cooler months of the year, and the "blizzard" may

occur in the warmer months. If the tornado may be represented by a single line ———— the "blizzard" may be represented by a series of lines ≡≡≡≡. That is, the tornado is generally confined to a narrow track, while the "blizzard" sweeps a wide path. The "blizzard" is more frequent in winter, or the cooler months of the year, for the reason that the conditions of the atmosphere are then the most marked; and for this reason the general winds of the cooler months are more severe than the winds of the milder months. On the map this is well indicated by the *gradients*. In the summer the contrast between the "HIGHS" and "LOWS" is not very marked, the *gradients* are far apart, while in the cooler months the contrast is great and the *gradients* are numerous and near together.

In order to produce the "blizzard" let a "LOW" go by to the eastward, and let it be followed by a very positive, extensive, and typical winter "HIGH," say the "HIGH 30.7" intensity, and this pressure covering an area of seven or eight hundred miles in extent. If in the train of the "LOW" there is much moisture, the cold from the "HIGH" will convert it into snow; combined with the fierce wind from the "HIGH," seeking to restore the equilibrium of the "LOW," the effect will be a cold, blinding storm, with more or less snow.

One of the most severe and protracted storms of this kind, without snow, however, was that in the vicinity of the District of Columbia in 1872, which lasted four days, from March 1st to 4th inclusive. Under these conditions it is exceedingly difficult to keep comfortable on account of the immense supply of cold, searching winds. The very sound of the name "blizzard" seems to be in harmony with its condition. It was evidently well named, and seems to be a modern word, at least as applied to a peculiar storm. It does not appear in the "Webster's Unabridged" of 1867, yet in the great Medical Library of the Surgeon-General's Office at Washington it appears as the proper or surname of an old English physician. So individuals by the name of "Blizzard," or Blizard, antedate, by many years, the name given to this peculiar meteorological condition.

In this connection it may be well to refer to the character of the precipitation. In the warmer months of the year it will, generally, in the temperate zones at least, be in the form of rain;

occasionally, more particularly during the summer "local," it may be in the form of hail. In the cooler months of the year, in the northern country, the precipitation will generally be in the form of snow, and even as far south as the Gulf of Mexico, when the "LOW" is in that region, and there is a good "HIGH" near to cool the atmosphere, or there is no north "LOW" to counteract the effect of the cold. With the north, or more northern "LOW," the snowflakes will be large; with the southern "LOW," particularly if there is a "HIGH" in the southwest, the snowflakes will be very fine and dry, almost like fine hail, and at times much like fine sand.

While the winds blow from the "HIGH," to the "LOW," it must be borne in mind that the winds from all the points of the compass are trending towards that centre. The result must be a compromise of direction. So while at a distance from "LOW," say four or five hundred miles away, the direction of the winds is straight towards "LOW," as they near the centre their direction will be changed, and carried considerably to the right. Hence what at five hundred miles away is a north wind, as it nears the centre becomes a northwest wind. And so as to all the points of the compass; this movement, or compromise of direction, is always to the right as we view the map after the ordinary manner. Yet oftentimes the winds, for even hundreds of miles, will move almost in a straight line between the "HIGH" and "LOW," and almost at a right angle to the nearest line between these two factors, before they curve to the right. And this accounts for the great amount of precipitation that so frequently takes place along this path where the clouds, when present, are concentrated. But the clouds are not always present, so we do not always have the precipitation with the winds. This was well illustrated by the map of February 12, 1892. The old "LOW" had moved to the northeast, which would seem to indicate warmer weather, but a "HIGH" which centered in Canada beyond our line of stations caused the winds to blow fiercely from the northwest, almost if not quite parallel with the *gradients* between "HIGH" and "LOW," while an additional though moderate and scattered "HIGH" in the west and southwest undoubtedly added to the intensity of this condition. And this only illustrates the variety of conditions that the meteorologist has to deal with; unlike any other branch of science

being more complicated; always some variation in the grand factors "HIGH" and "LOW;" some variation in their relative location, in their degree of pressure, in their speed, outline, and direction. A change in any one point will alter the general character of the whole.

The direction of the winds in their movements towards the centre "LOW" is, we see, very peculiar, and, like all the other points in meteorology, of infinite variety. At the greater distance the line of movement is straight towards the centre. About half way between the "HIGH" and the "LOW" the direction becomes quartering; while at the very centre, on account of the action of the winds upon each other, there is often no wind at all, or a dead calm.

The study of the daily weather map, we see, is all important to those who seek wisdom from nature, and who desire to know all that it is possible for man to know of the laws that govern that portion of creation that lies between the solid earth and the heavens that are above the earth. The weather map made it possible for us to comprehend this intermediate condition or connecting link between the surface of the solid earth and the vast domain beyond. It is, as it were, the "Jacob's Ladder" that connects the two. At times we are inclined to think that man in this world commences at the centre and builds outward in regular order to the vast fields that lie so far beyond him. But in practical reality this is not so. In many fields we only repeat the experience of the building of a city or the settlement of a country. Cities and countries do not grow on this principle. They start with a centre, then other little centres spring up at points remote from the first centre, after which the larger and smaller centres grow towards each other. Our experience in acquiring knowledge of the physical conditions of the universe is much after this order. Had we followed the regular order then we would have learned all about our earth before any steps were taken to go beyond. Then we would have passed on to a knowledge of the atmosphere, and when this was fully grasped we would have extended our lines into the regions known by the conventional name of "space," where the other planets and suns have their allotted territory and tracks in which to move. But this plan, whether by design or accident, was not followed. Before man ever knew much about

the planet which is his birthplace and home he sought and obtained much knowledge of the "great beyond."

At a very early age the science of astronomy was carried to a high state of perfection. We will not say but what there is still more to learn of the mysteries of the great outside worlds that occupy the infinite space, or seemingly infinite space, so far remote from us; indeed, modern instruments have made it possible for man to-day to know even more of what occupies this wide space that surrounds our insignificant earth than was known by the early astronomers. Still, their wisdom in this line is highly commendable, and we accord to them the highest honors for attaining such scientific lore under such adverse circumstances. Thousands of years passed before even the wisest men then living knew what is now taught to children as the fundamental principles of geography. But when a start was once made in the right direction, then, with the accumulated wisdom of the ages, only a few hundred years were required to perfect its wonderful geography and to inaugurate new and surpassing features in the development of the human race. Our world took a new start from the time that Columbus discovered the Western Hemisphere, and Magellan circumnavigated it and thereby proved it to be a complete globe or circle.

The daily weather bulletin is a wonderful thing, but then it is only a small part of the revelations of the map. Many books have been written on the subject of climatology, but a careful study of the map will reveal more as to the climatology of any place within a given domain where a map is published than all the essays and books ever written about it. Do we care to study understandingly any phase of the weather, of any place or section, as the peculiar contrasts between the climates of the Atlantic and Pacific Coasts; why the temperature of the northern Atlantic seaboard is higher in summer than that of the Pacific on the same line of latitude, and colder in winter; and why the climate of the California coast is more even, not such excessive heat in summer nor intense cold in winter—it is all on the map. In the east the general track of the "LOWS" is towards the St. Lawrence Valley, which produces the heat of this section. In winter the intense and widespread "HIGHS" come, and the result is periods of intense cold. On the Pacific Coast, the "LOWS" enter the country in the northwest and southwest, while the "HIGHS" centre about

in the region of Cape Mendocino, from which their general line or course will be towards the Lake Winnepeg region, the while gathering intensity, and, dropping to the south, or towards the centre of the United States, produce intense cold throughout the central and eastern sections of the country. On the Pacific Coast the north and south "LOWS" neutralize each other, and the "HIGHS" between keep the temperature cooler. In the winter the north "LOW" drops a little, and so brings the central country more under the influence of the wet factor. The "LOWS" that enter the country at the head of the Gulf of California take various directions, but often take a northeast course, from here, towards Manitoba. So if you desire to study the climate of our country, any section of it, or the peculiarities of any season of the year, it is all revealed on this wonderful map.

Take that interesting phenomenon that occurs in the fall of the year, known as "Indian summer." The solution of the mystery is all spread out before us on this map. To sum it up in a few words, it is the result of a moderate "HIGH" and "LOW" condition, extending into the early fall, when the "LOW" is as far north, or even farther north, than 50° north latitude, and the "HIGH" is in the Gulf States, with the *gradients* far apart.

Or, perhaps, we might like to know something of that beautiful phenomenon known as the "Red Sky." It is all on the map, and had the parties who undertook to credit this beautiful display to the dust from a volcano been familiar with the map, and studied the relations of the "HIGH" and "LOW" on these occasions, they never would have thought of so contemptible a thing as dust as the cause, to say nothing of the impossibility of dust travelling around the world in the manner claimed. No dust ever created by any such a condition would have the brilliancy of coloring to produce such effects. The map shows us that the movement of the atmosphere of the world is from the west towards the east, and combined with this general movement there is the while a sub-hooplike movement, back and forth, up and down, whereby the atmosphere is moved along and the while thoroughly stirred up in every direction. The "LOWS" will average two thousand miles from centre to centre, making some six centres for half way around the world, and only one belt at that, to say nothing of other belts to the north or south thereof.

The atmosphere of the earth is said to be forty-five miles high; but no matter how high, forty-five miles, more or less, whatever the height, the whole atmosphere is affected by the action of these "HIGHS" and "LOWS." So no matter how high some dust might be thrown in the air, even to eighteen miles high, it could not be thrown above this influence of the general movement from west to east, centre, vertical, and circular movements from all points of the compass and at all angles to the horizon. Possibly some dust might get past one "LOW" centre, but I doubt it; but what little might get by one would not get by a second. The actions of these "LOWS" would precipitate the dust before it had gone two thousand miles. Yet, with all, they tell us that this dust at a height of eighteen miles went around the earth much like a flock of birds, from *the east towards the west*, that it all kept in a body and moved as a planet might move! The weather map does not support any such a view of the beautiful phenomenon known as the "Red Sky." The map shows that it is caused and took place under a peculiar condition and juxtaposition of the "HIGH" and the "LOW;" that vapor and not dust is the cause of the brilliant and delicate coloring, Water is the peer of the diamond in this matter. Dust has no such power, while water has. The map shows that certain conditions will produce certain effects, and that these conditions are all the while changing. The "HIGHS" and "LOWS" which form these conditions do not pass over the country in any regular order, but collectively move like the individual "HIGHS" and "LOWS" themselves, on very general lines. For example, in the spring of 1880, many "LOWS" were passing over the country that would move from the southwest to the Lake region, then down towards Cape Hatteras. Since then few "LOWS" have taken this course, consequently the general effect has not been the same. Every day, week, month, year, decade, and cycle has its peculiar and more or less positive variety. So, while we have not had the general conditions so favorable for protracted and often-repeated exhibitions of the "Red Sky" we have had, and do have, more or less of the exhibition every year. The condition necessary to produce the phenomenon is a well-marked "HIGH" to the south in order to give the clearness to the atmosphere, and a north "LOW" to give it the warmth, with

the *gradients* closer together then in the combination forming the "Indian summer" effect.

In recent articles by the advocates of the dust theory, they have, in this connection, asserted the highest claims for dust. But for dust the water in the world would have no special value or beauty. Dust, according to these writers, is the neucleus of all our precipitations, whether in the form of rain, hail, or snow. And as to artistic coloring in particular, water has no color but blue. So all the other colors we see in the waters of the world are not inherent in that element itself, but merely and wholly owing to some dust that somehow gets associated with it as an all-important agent, whether artistic or practical; therefore, when we look upon the beautiful expanse, of the oceans, seas, bays, lakes, rivers, ponds, and even creeks of the world, and see reflected there all the beautiful hues that delight the artistic eye, let us think to ourselves that but for dust all this beauty would not be. When we see the spray from the waves, as it dashes upon the shores or upon our barks as they plow the sea, and breaks in foam resplendent with the gorgeous coloring of the rainbow; when we see the rainbow itself, in all its magnificent glory, as after the summer "local," when it would seem if there was any dust in the air it would ere this have been washed to the ground. When we gaze upon the waves and upon the magnificent bow of promise, let us for one moment put ourselves in harmony with the dust philosophers, and try to conceive of all this beauty as being wholly due to dust; that water has no power to reflect or set forth such beauty; that it simply forms an inferior part of the compound that does form it; that all the beauty as well as the practical utility you see is owing wholly to dust! It may be that these gentlemen, owing to their rank and influence, may get the world to accept their views in this department, but I, for one, doubt it. It looks very much as though they unwittingly, on account of not being familiar with that wonderful illuminator, the weather map, committed themselves in 1883 to the advocacy of the Krakatoa dust theory as the cause of the beautiful red sky, and now they are determined to adhere to it and to bend everything in that direction.

The public, because of their ignorance of the weather map, have been greatly imposed upon by a class of men calling them-

selves "weather prophets." But the greatest imposition of all is that practiced by the man who attempts to pose as a modern meteorologist, perches himself on some high elevation, and endeavors to make the public believe that his success in this line depends upon and is due to the height of his aerial quarters. The man may add a few miles to his horizon; but while this may seem advantageous to local eyes, when we come to consider the extent of the field and the comparative insignificance of the scope of the vision of man, principally owing to the rotundity of the earth, this is as nothing. From the statements of these men it is quite evident that they are students of the weather map, and have some means of seeing its daily issues, or having its secrets communicated to them in some manner. For from one isolated station, and nothing more, it would simply be impossible for them to act the prophet with any more success than the ordinary local guesser. Some people, we know, become quite expert in guessing of the weather, but they cannot compare with the map, any more than the vision of the barnyard fowl would compare with that of the eagle in its flight over an extended country. It would seem that there was nothing more despicable or beneath a scientific man to do than this. For him to have the advantage of the best scientific light that the wisdom of the age affords; for him to conceal this light from the public, and to endeavor to make it appear that he is groping his way in common darkness with the great mass of his fellow-men, while all the time his path is well lighted by lights unseen and unsuspected by them; for him to do this is most dishonorable, and unbecoming in any one who would be known to the world as a scientist and gentleman.

Then there is another kind of prophet who seems to think that nature travels in some regular cycles, and that he has discovered the great secret. Once in a while these men have a fortunate "hit," and for a short time their reputation is great. If a man knows the channel of a river he should be able to map it, either direclty or indirectly; so if a man knows all about the weather, he should be able to map the currents of the atmosphere, give the location and movements of the "HIGHS" and "LOWS," whereby the changes of the weather are wrought. Here will be a practical test for the weather prophets. If they know what the weather will be, certainly they should be able to sketch the same

on paper; not some mere conventional or approximate map, but something that will give, in advance, the exact outlines of the "HIGHS" and "LOWS," together with the isobars and isothermal lines.

The only way to be a meteorologist is to be a student of the weather map. The mariner might as well attempt to guide his bark over the wide ocean, to the distant port, without the charts and instruments of navigation, as for any man to attempt to assume the role of meteorologist without a knowledge of the map; for by the map he not only knows what is the condition of the atmosphere immediately about him, but he knows what it is to the north of him, to the south, east, and west of him. Oftentimes the storm may be very near, and yet there be no signs in the immediate horizon. This is particularly so when the *gradients* are close together. Then the signs may be all right, but the locality being within the outer lines of the "HIGH," the storm may pass so far to the north as not to affect our locality, as is frequently the case when the "HIGH" lies along the Atlantic seaboard.

That there are certain changes in our atmosphere no intelligent person will deny, but there is no regularity about them, not even as to the temperature of given latitudes. The most even temperature and uniformity of weather is evidently where the Sun's rays are the most direct, but in what are termed the temperate zones the changes are infinite. Many a mathematical calculation has been made to prove that the climate of the earth, on account of its cooling process, and the supposed failing powers of the Sun, must be gradually getting colder. But of late the winters in some sections seem getting milder. The winter of 1890–'91 was very severe in Europe, while the same winter in the Western Hemisphere was exceedingly mild in comparison with what are known as "old-fashioned winters." Now, here was the same Sun, within the same twenty-four hours, shining on the different sections within the same lines of latitude, yet in one case the weather was severely cold, while in the other it was remarkably mild. Why such a result? The "Sun-spot" philosopher attempts to figure it out on the basis of the "spots" on the Sun, and he never seems to think how absurd it is for any "spots" to have any such an effect. It is exceedingly queer how these "spots" in the Sun

can select "spots" or mere localities on the earth, and affect them in a manner peculiar to localities and sections. It is about on a par with the Moon's influence, that is expected to make a multitude of changes on its rounds of the earth, all in one night: create a storm in one place, and drive away a storm in another place. The weather map lifts our minds above the earth and shows us the mysterious factors that are moving over its surface, from the west towards the east, or ever towards the rising Sun. In some places the "HIGH" (barometer) prevails and in other places the "LOW." The "LOW" and the "HIGH" go on their irregular rounds, and produce their irregular results.

Had the Creator organized these factors on a regular basis then the results would have been regular, and the mathematician could have figured them out as he does the movements of the heavenly bodies; but there is no place for the mathematician in meteorology beyond the mere detail of reducing the barometric pressure to the sea level. And as this has to be done and is done, it shows the absurdity of the supposed advantage in stations at high altitudes. From the very nature of things irregularity and not similarity must be the order of these movements. So long as the surface of the earth is irregular, so long must these changes be in harmony therewith. The movements of the "HIGHS" and "LOWS" on land are the most irregular. Their courses across the United States (*i. e.*, on the land) is exceedingly so; but across the ocean, where it is all one element—water—the courses of the "LOWS" are reported to be quite straight; but even with this in their favor, the results are apparently never twice alike there. Yet, with all their diversity of course, extent, shape, and intensity, there are periods of general similarity, when the "HIGHS" and "LOWS" will move on such lines as will produce these similar results. While there are winters when the areas of "HIGH" will be phenomenally extensive and intense, and when the "LOWS" will predominate on an exceedingly low line of latitude, *i. e.*, moving repeatedly across the cotton States and up the Atlantic seaboard, rather than on the higher lines of the Lakes and the St. Lawrence Valley, the same winter may or may not produce in succession the same juxtaposition and development of these great meteorological factors known as "HIGHS" and "LOWS." A variation of only a few degrees of latitude in the

"HIGH" and the "LOW" will make all the difference in the world, and this variation may take place the same season in countries of the same latitude. The areas of "HIGH" and "LOW" carried up or down a few degrees make a wonderful change in the climate of the country over which these factors exert their influence. And this illustrates the peculiar changes even in the climate of the polar regions. Because it is a mild winter in the middle zones it is no indication that it is mild in the polar regions or the reverse. The movements of the "HIGHS" and "LOWS" may be such that the winter weather of the North Pole, for example, may be comparatively mild in the same winter that the cold is comparatively severe in the north temperate zone.

Possibly, after the present system of gathering facts is applied to the whole earth, we may, after many years, discover some regularity of movement in these factors, but I doubt if that day will ever come, for since the map has been established here in the United States, while occasionally a map is similar in some detail, the maps as a whole are quite unlike. The variety seems infinite, and even as a study in variety it is exceedingly interesting. Take the outlines of the "HIGHS" and "LOWS." Their variety reminds one of the kaleidoscope. Their rate of travel is never regular; they will remain almost stationary or even move towards the west for twenty-four hours at a time. But these peculiarities are the exception; their general direction is towards the east, and their average speed in the neighborhood of four hundred miles a day, but they frequently travel seven and eight hundred miles, and sometimes fifteen hundred miles, in twenty-four hours. If the "LOWS," as herein stated, travel towards the Sun, it seems quite natural to ask why they do not, from the middle of the day to sunset, travel towards the west. In the first place, the general-pull is towards the east. On an average, about twelve "LOWS," and as many "HIGHS," in one belt, encircle the earth. We will start from any arbitrary point and call that No. 1, and number the "LOWS" around to the west. The Sun at first shines upon and heats some point in the east, then passes on to other and other points, until the whole circle of the world is under its influence. The power of No. 1 will act on No. 2, No. 2 on No. 3, and so on the world around. And this is what I mean by the

general-pull. Then, in addition thereto, the bank of "HIGH" that is necessarily in the west will evidently have some influence to repulse rather than to attract any advance in that direction. What as to the "HIGH" that is in the east? it may be asked. If this stood still, or was moving itself towards the west, then it too would repulse; but that is moving away from the "LOW," or toward the east, and is, therefore, a part of the general-pull herein referred to. Then in addition to varieties in these lines, the intensity of the "HIGHS" and "LOWS" are ever changing. For no great length of time is the pressure the same. Variety in all its forms is what we see depicted on the weather map.

And herein is the great difficulty in forecasting the weather. It cannot be worked out by any set rules or by any system of mathematics.

We must familiarize ourselves with the map, notice the lines on which the "HIGHS" and "LOWS" travel, bearing in mind that the general direction will be from the west towards the east, and by intuition solve the problem, as it were, by a good Yankee guess, the best we can. At times, when the "HIGHS" and "LOWS" are well defined and moving quite regular, we may make a forecast that will prove more accurate for even four or five days in advance than at other times for only twenty-four hours in advance. Experience with the map will fortify us in this matter, and it is the only medium whereby we may become successful weather prophets. If, however, an "indication" is ventured, and instead of it coming to pass something quite the contrary happens, and the map of the succeeding day shows good reason why, to any sensible mind it will be evident that there was no mistake when it is seen that some phenomenal factor has been introduced into the problem that materially alters the result. For example, we cannot possibly know that a "LOW" will travel in the coming twenty-four hours fifteen hundred miles, or that it will take some phenomenal direction. We have certain facts to guide us. On these we must base our calculations on what seems to be the most probable as to the speed and direction of the "LOW." If, however, we do not interpret these in accordance with the best evidence of the map, then we must be responsible; but if another effect is produced, and the map of the succeeding day *shows good reason why*, then in all fairness no mistake, as such, should be charged to us.

If we say that in the eastern section of the United States it will be cold "to-morrow," simply because there is a "HIGH" in the far northwest, and do not take into consideration the pressure of this "HIGH," nor heed the influence of the old "LOW" in the St. Lawrence Valley, we make a mistake, and should be responsible. The eastern section of the country under these conditions will not, as a rule, feel the "cold wave," even when the state of the "HIGH" is favorable, until the north "LOW" has passed beyond an influencing distance; then the "HIGH," in order to produce the full "cold-wave" effect, must be of due intensity, say 30.4 and upwards, and must move on such a line as to cover the section of country that is promised the "cold wave."

The conditions that are the easiest for successful "indications" are when the "HIGHS" and "LOWS" are passing quite regularly and centrally over the country. But when only the outer lines of the "HIGHS" and "LOWS" pass over the country, and the centres are far to the north or south, forming a little point of "HIGH" and a like point of "LOW," the changes are necessarily so variable that it is impossible to make what may be termed a "long indication." At these times the "indications" must necessarily be for short periods, twenty-four hours in advance being the limit.

The development of the skeleton map idea would greatly favor the indication department; for then we could have reports, morning and evening, from all over the country, and thereby, at least twice a day, be informed as to the exact condition of our atmosphere.

In this department the great duty of the hour is to extend the stations; and, as the movement is from the west towards the east, a station in the west is of far more importance than one in the east. In the eastern half of the United States the stations, at least many of them, are within fifty miles of each other, while west of the Mississippi they are even two and three hundred miles apart. Less stations in the east and more in the west, the perfection of the service would seem to demand. Then there should be a few stations through Mexico, whereby we could the sooner be forewarned of the "LOWS" that come from that quarter. It would pay the United States to establish a number of stations in Mexico. We need not have a greater number of stations than we have at

present, but many that are in the eastern half of the United States could be transferred to the west and southwest, and some of them distributed at desirable points throughout Mexico. The whole country would reap the advantage of this arrangement, and the public interests even demand it.

As the world begins to appreciate the modern weather bureau it will become more and more generous in its support, and be more alive to the establishment of stations all over the world. Stations on a square of every one hundred miles would give very satisfactory results. Could we not have a reciprocity with the nations of the world on this subject? Surely the whole world would reap the advantage, practically and scientifically. By having such an extended territory as the United States, all under one jurisdiction, we have, within twenty years, learned more about the atmosphere of our globe than in all the thousands of years prior to 1870. We have, through this advantage, grasped the principles—principles that I think the future will substantiate and endorse, and the extending of them will only add more beauty and interest to the intelligent people of the future. As the map is all important, it would seem full time that its influence was extended. The only trouble with it at present is the time that is required to transport the daily copies to distant places. And as the movement is from the west towards the east, by the time a map published in Washington could reach the Pacific Coast it would be a week old. The attempt has been made of establishing sub-centres, but this is very expensive.

A skeleton map, however, would seem to meet the demands of all sections and be immediately available. Let, then, be printed, at the government expense, skeleton maps of the United States, size immaterial, say 10 x 16, or even as large as the present daily map. There even might be miniature ones that could be printed in the daily papers of the country. These maps to be divided into a conventional number of squares, and these squares to be numbered or lettered. The most comprehensive method would probably be to number the squares, and to letter the angles of the squares, which would give a finer grade or scale, whereby to comprehend the location of the "HIGHS" and "LOWS." The morning and evening papers, in their telegraphic news, to give the location of the "HIGHS" and the "LOWS," and it would

also be well for them to give the general *gradients* and isothermal lines. This might seem a little complicated at first, but the advantages to be derived from it would soon recommend it to favor and surmount all seeming difficulties. The maps may also be on blackboards in newspaper offices, and other public places, and when the report comes in some handy individual, by making a few lines with chalk on the board, can make the weather wisdom of the country exceedingly plain to all who will take a little trouble to comprehend it. And it will be comprehended even more readily than we might think. The practical minds of the street are wonderfully quick in comprehending when once they see some advantage to be gained by it.

We can have ample stations on the land. What as to the sea? it may be asked.* Stations undoubtedly can and will be eventually established on the seas and oceans of the world, and a seemingly practicable plan has been devised. The future will undoubtedly grow to it.

The weather map, even in its present condition, has been of great benefit to the world. We will not attempt to say what the future may do for the map. Perhaps a short-sighted and narrow interest may prevail; if so, the world will only be the loser. The practical and scientific requirements of the age go hand in hand and demand its extension as herein set forth. It is to be hoped that the controlling element of the world will acknowledge its claims and steadily advance them. There is no knowing the possibilities of the map. Its field is cosmopolitan, and it bids fair to become one, if not the chief, agent of the world in uniting the common interests of humanity, making the whole world, as it were, one family, and a potent agent in bringing to pass that good saying of the old Hebrew prophet, "Peace on earth and good will towards men."

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*A Plan for Life-Saving Stations in Mid-Ocean. Kansas City Review, February 24, 1879. Reprinted in the Journal of Science, London, May, 1879.

EXPLANATION OF PLATES.

PLATE I represents the general tracks of the "LOWS." They enter the territory of the United States at four general points: At the extreme northwest at B; in the southwest at A; through Mexico and Texas at D; and at the southeast at E. The one that enters at B may go straight across the country towards F, or it may take a southeast course towards J, then turn and go northeast towards the mouth of the St. Lawrence. It may branch off at G and travel nearly due east to L; from L down to Cape Hatteras or M, and then northeast to F. As a rule, the storm centre, "LOW," will not be over twenty-four hours in passing a certain point, but sometimes the movement is so slow that it will not get by inside of forty-eight hours, even when travelling on a straight line, as from G to L. Then again the course of the same "LOW" may be such as virtually to pass some locality a second time. The locality of Washington is favorably situated for this. From L "LOW" will sometimes move down towards M instead of taking its more common course from there to the mouth of the St. Lawrence. So Washington will be under its influence while it is moving from L to M, then again while it is moving from M towards F. On these occasions people not familiar with the weather map will say the "storm hangs on;" they do not realize that it is on the move all the while, as it were, taking a V-course about this locality.

The "LOW" that enters at A may take a northeast course towards H and then due east, or it may travel east *via* points J and K, or on any lines between them. There seems to be no end to the variety of their courses.

The "LOW" from the West Indies, entering near or at the southern point of Florida, at E, may skirt the coast and produce hurricanes along the southern Atlantic seaboard, or it may strike

inland in the direction of K, and even travel towards the northwest for a day or two, then turn towards the northeast. During the winter these southern "LOWS," from Mexico, the Gulf, or the West Indies, on account of the latitude from whence they come, oftentimes produce snow in the southern half of the United States, sometimes as far south as New Orleans. When, however, they produce snow so far south as this, it is quite essential that there be a good "HIGH" in Mexico and Texas, in order to reduce the temperature of the atmosphere to a proper condition. The "HIGHS" in this region produce what in the lower

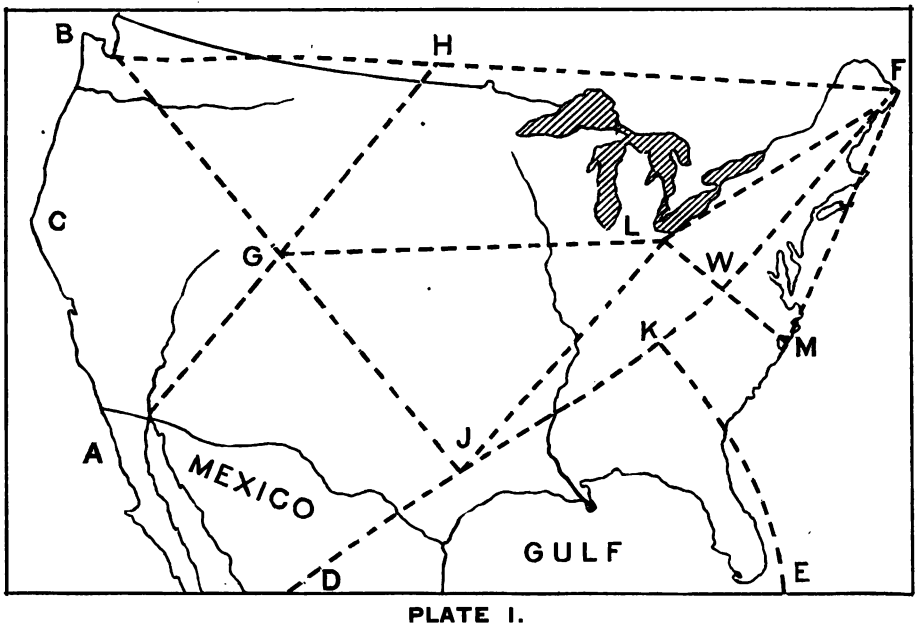


PLATE I.

Mississippi Valley is known as the "norther." The south "LOW," moving northward toward the Gulf of St. Lawrence, produces what in olden times was called the "northeast storm"—a cold storm, sometimes rain and sometimes snow, all depending on the positions of other "HIGHS" and "LOWS," which more or less affect the character of the whole atmosphere of the United States. Accompanying north "LOWS" would reduce the temperature so as to cause the precipitation to be in the form of rain, while a central "HIGH," moving from the west towards the east, would

so reduce the general temperature as to produce snow. As to matter of fact, there is no "northeast storm." The south or southwest "LOW," advancing towards the northeast, produces the northeast wind, whence these storms took their name.

Then the northeast wind is not always the forerunner of a storm, for once in a while we have most delightful weather, extending into days, with the wind northeast. If we will but consult the weather map the cause is thereon plainly revealed. It is the result of a northeast "HIGH." "LOW" prevails in the extreme northeast; but once in a while a "HIGH" will move on to that territory, and when it does the character of the wind from that quarter will be dry and the atmosphere very clear, making what may be termed the *dry northeaster.*

PLATE II represents the central "HIGH," with "LOWS" in the extreme northeast and northwest. With this condition and juxtaposition of "HIGH" and "LOW" the isothermal lines will run, in horseshoe form, from the northwest down to the Gulf, then up towards the northeast, and it will be as warm at F and B as at J, or as cold in the southern portion of the United States as in the extreme northeast and northwest. As to the amount of sunshine, it is within the bounds of reasonable statement to affirm that practically it is ever the same; that it does not perceptibly vary. Yet it is a subject about which there has been much discussion, and people do not seem to understand why, on a clear, bright day, with not a cloud to intercept the rays of the sun, it will oftentimes be colder than when a condition of cloudiness prevails, when there has even been no local sunshine for a number of days. The simple solution of the problem is readily explained by the map. As herein stated, "HIGH" is a cool, dry factor, for the reason that no warm airs are flowing towards it to heat the section over which the "HIGH" prevails, while "LOW" is a wet factor, and warm or cold in proportion to its latitude. With an extensive central and positive "HIGH," as shown on Plate II, the atmosphere will then be clear and cold. The sun will shine, but its warmth is not sufficient to overcome the intense cold of such a "HIGH," while if the "LOW" is to the north, for hundreds of miles to the south thereof the sunshine will not be visible, in its track, on account of the cloudiness engendered. But it will be relatively warm for the reason of the north "LOW" carrying the warm

airs far to the north. The mere fact of the sunshine does not create heat at the point of visible sunshine. The heat from the sun, in order to heat to advantage, must be continuous, and be the cause of bringing to some north point the warm winds from the well-heated southern fields.

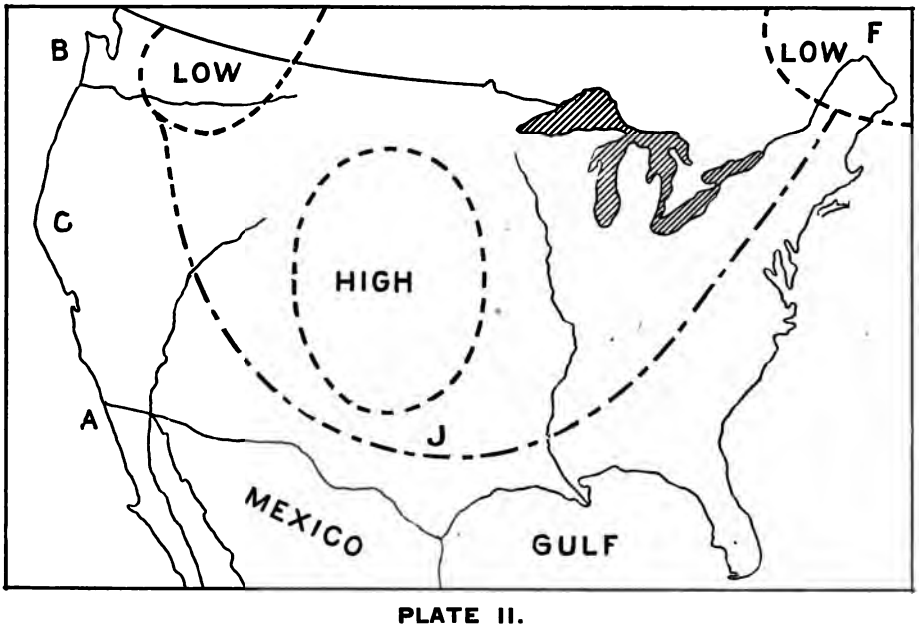


PLATE II.

PLATE III shows the general condition and situation of "HIGH" and "LOW" in order to produce the tornado or cyclone—"LOWS" in the north, moderate "HIGHS" in the south, and perhaps along the Atlantic seaboard, with a new "LOW" advancing from the south or southwest. This plate, slightly modified, with the "HIGH" stretching through the cotton States, west and east, with a summer intensity of 30.2 or 30.3, with the summer "LOW" spread over the north country, with an intensity of about 29.9, the *gradients*, far apart, will give us the Indian summer weather, about which so much poetry has been written. Now intensify both the "HIGH" and the "LOW," to the extent of giving us a clear sky in the middle regions of the United States, and we will have the red-sky effect. The stronger the contrast, the finer the effect. Probably the most favorable con-

dition for the red sky is to have the northern line of a "HIGH," with the *gradient* of 30.0 or 30.1, at about 40° north latitude, and extending far enough east and west, say 500 to 700 miles, in order to give an atmosphere, over a large area, with a minimum of moisture. A "HIGH" lying along the Atlantic seaboard, with its longer axis southwest and northeast, makes a very good combination, for this allows the warm airs from the Gulf to pass near the "HIGH," yet without interfering with its delicate atmosphere. The "HIGH," though, is only one factor; the other must be a north "LOW," for the purpose of conveying the airs of the south

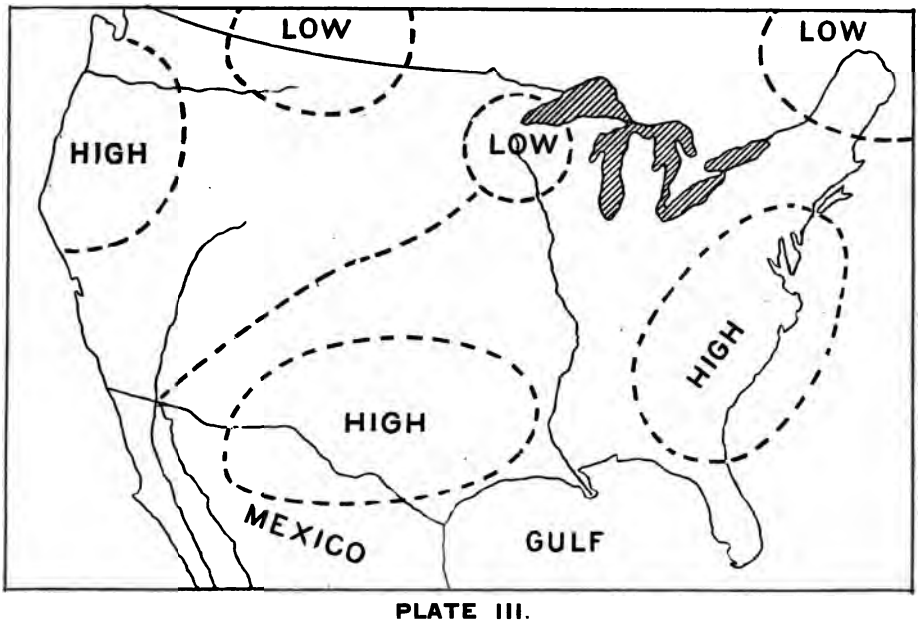


PLATE III.

far to the north, whereby the necessary heat is obtained. The best proof we have of this solution of the red sky is the fact that it is only seen under the conditions herein referred to. If there were any value to the assertions of those who support the dust theory for producing the red sky, and for their claim that dust is even the neucleus of all moisture in the atmosphere, then the color of the sky under a cloudy condition, such as we have in the confines of an area of low barometer, should be very much colored, and all the areas of low barometer, that for months followed the

Krakatoa eruption, should have produced a very red atmosphere. But they did not, and the beautiful redness was only seen under the conditions spoken of.

PLATE IV shows the condition to produce the warm north winds. After the north country has been warmed by a series of north "LOWS," let a moderate "HIGH" appear on the scene, and let there be a moderate "LOW" in the south. The winds, although from the north, will, for a few hours at least, be relatively quite warm, or until the warm air of the north country, caused by

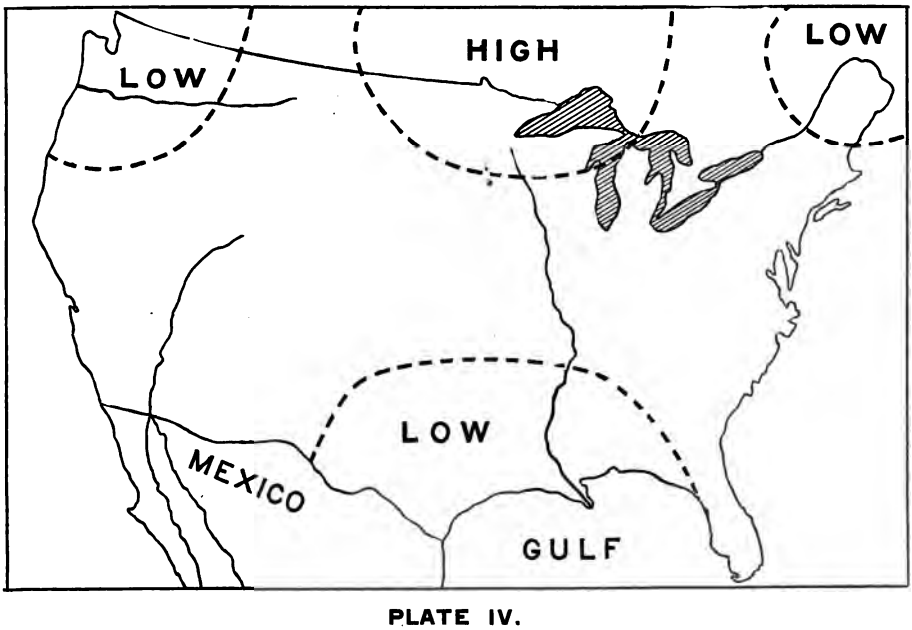


PLATE IV.

the north "LOWS," is exhausted. Reverse this and put a good "HIGH" in the south, 30.4 at least, and a "LOW" in the north, and the result will be relatively cold south winds.

The winds from the "HIGH" are relatively cold; the winds towards the "LOW" are warm or cold in proportion to the latitude of the centres of the "LOW;" *i. e.*, if "LOW" is far to the north, the winds thereby produced will be warm, while if the "LOW" is in the south, whereby north winds will be engendered, the same will necessarily be of a low temperature, or cold winds.

PLATE V shows the condition in order to produce the "blizzard." A "LOW" of low intensity, with a centre of about 29.4, followed by an extensive and high-grade "HIGH," with a pressure of 30.7, and covering an area of seven to nine hundred miles in diameter, will produce what may be termed a first-class "blizzard." When such a reservoir of air has been piled up and a way is made to draw it off in a favorable channel, it will go with a tremendous force, and continue, so far as a certain locality is concerned, until it has passed so far to the eastward as to be unble to affect it further. A new north "LOW" from the west will oftentimes appear on the scene, and in a day or two introduce a striking change in the temperature in the regions over which the blizzard has passed.

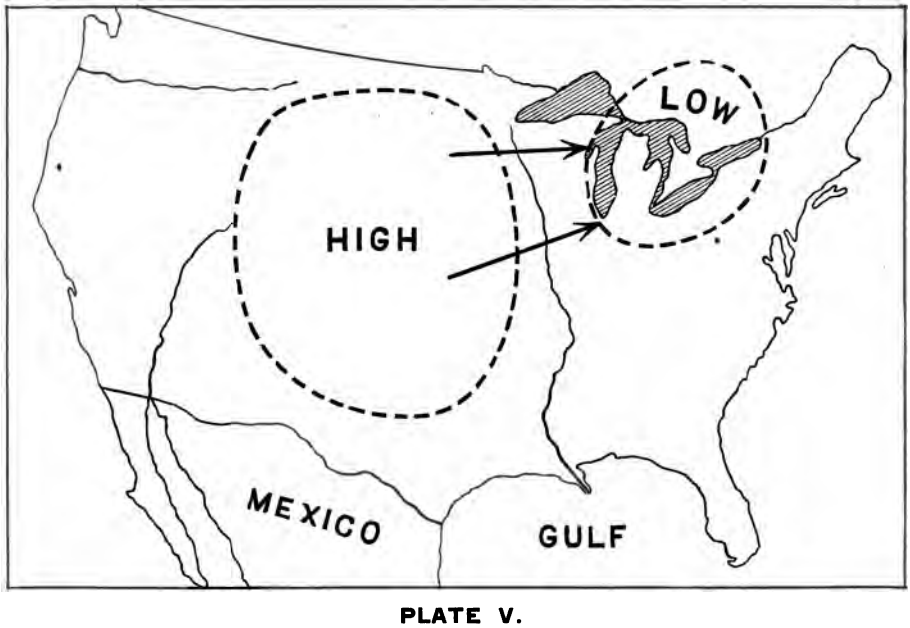


PLATE V.

PLATE VI, square J, represents the winter condition of the atmosphere, while square K represents a summer condition. Let the line AB represent the line of low barometer in the winter, the line CD will represent the maximum or highest point of the "HIGH," while in square K, EF will represent the line of the

summer "LOW," the line GH will represent the "HIGH" line of summer. That is, baring the "local" conditions, the atmosphere during the summer months is in a very normal condition, while in the winter months it is in a very positive condition; the "LOWS" are very low and the "HIGHS" are very high.

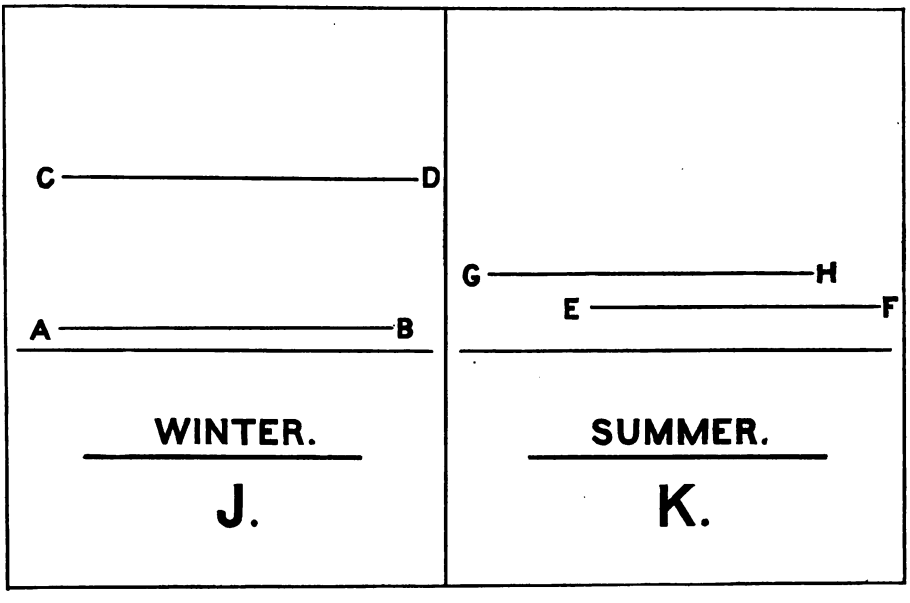


PLATE VI.

PLATE VII is an ideal representation of a section of the atmosphere showing its sub-movements. Let AB represent vertical lines drawn through the centres of two "LOWS," and let the line CD represent the centre line of the intermediate "HIGH." Towards and at the head of the column "LOW," near B, the movement of the atmosphere will be from B outward towards D. In other words, the air at the centre of "LOW" follows very much the lines of the boiling water in the pot, as it were, boiling over towards D. "LOW" is the while building up the "HIGH" at the top, while the action of the "LOW" at the bottom is drawing from the bottom of the column "HIGH." Thus the eternal "round" of our atmosphere. The centres "LOW," probably a number of belts of them, continually pushing their way into

the east, or towards the rising sun, and the while the atmosphere about these centres rolling over and over, drawing the supply from the base of the column "HIGH," conducting it to the column "LOW," where it ascends and boils over and builds up the "HIGH," only to descend again and supply the current that is the while on the move from the "HIGH" to the "LOW," a complexity of motion that keeps the atmosphere ever on the move, generally towards the east; locally, in every conceivable direction. This is nature's plan for renovating and purifying the

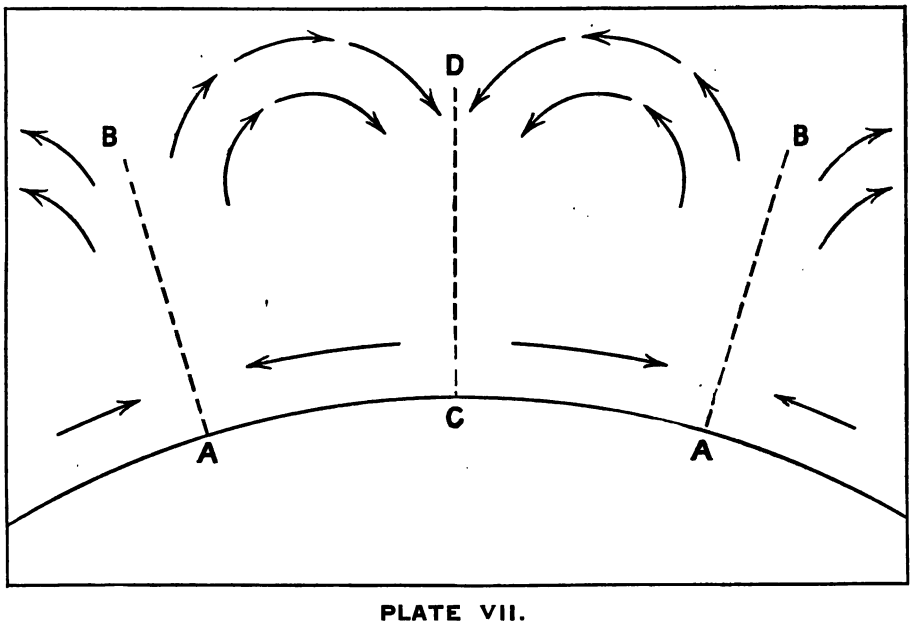


PLATE VII.

atmosphere of the world by sunlight, cold, heat, and rain. The grand result is a pure and life-giving atmosphere, daily and even hourly renewed and purified, and well typifies the saying that "in action there is life." The atmosphere knows no rest; at times it may seem sluggish in its movements, but the movement is the while going on, and we can no more perceive it by the individual eye than we can realize the movement of our planet through space.

PLATE VIII illustrates the skeleton map idea. By having the squares *numbered*, and the angles of the squares *lettered*, the centres of the "HIGHS" and "LOWS," and the *gradients*, or isobars, and the isothermal lines may the more readily be described. To illustrate a daily report: "The old 'LOW' is centered on F, intensity 29.4. An extensive and high-grade 'HIGH' in the west, centre 30.7, covers the squares 10, 11, 17, and 18. New 'LOWS' entering on squares 1 and 29. In the eastern half of the United States, the isothermal line from square 14 to W." An arrangement so simple would not seem difficult to understand, and

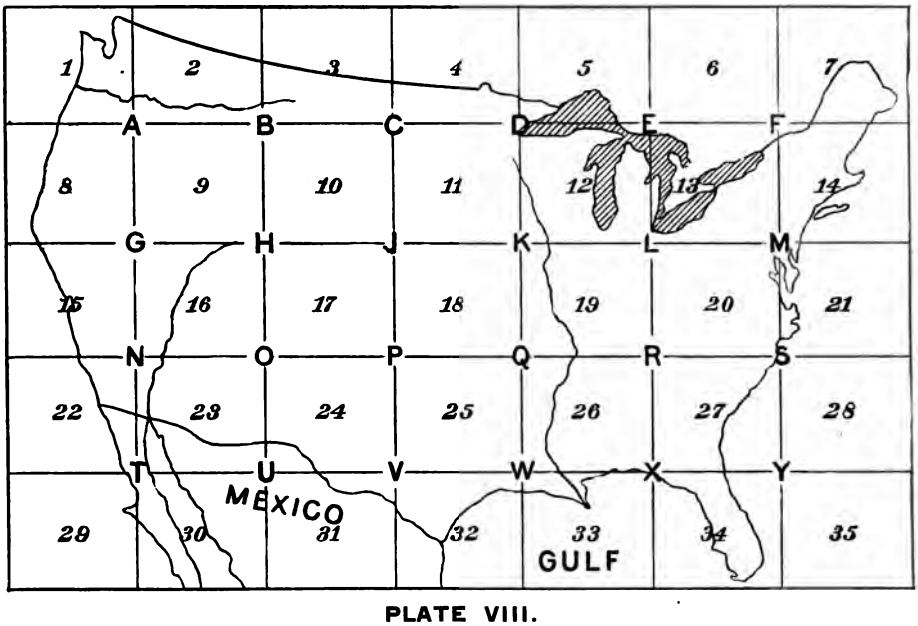


PLATE VIII.

would be a most practical and ready medium whereby to convey to the public a very comprehensive idea of the condition of the atmosphere of the whole United States. It would not require much of a mental strain to keep these points in view. At first it might seem a little difficult, but the practical and aspiring minds of the day would soon grasp it, and even reduce it to a minimum form, as the telegrams of the business world are reduced, without even loss of important matter.

When the idea is once started, and the subject-matter fixed in the mind, it will be found exceedingly easy to follow, and not at all difficult to carry in the mind the relative positions of the "HIGHS" and "LOWS," and their changes, from observation to observation. In our morning and in our evening papers we may read the information, and even a miniature map may be published in the columns of the paper itself. If we will but read this, and then glance at the map, we will readily comprehend the condition of the atmosphere over the whole United States, and when the system is extended over the whole world, with very little additional trouble, comprehend the daily changes of the atmosphere of the whole world itself. The meteorology of the future will evidently embrace this idea.

It is all important that the knowledge of our atmosphere be now known to at least all intelligent persons. More is demanded of the world now than during the last century. Even within the years of the present generation the demand has wonderfully increased, and it is surprising how the knowledge of one department leads up to a better insight into another. For example, take the great and mysterious power known to the world as electricity. As a toy it was known to the world many years ago, but its development depended upon the developments of the physical world through the agent steam.

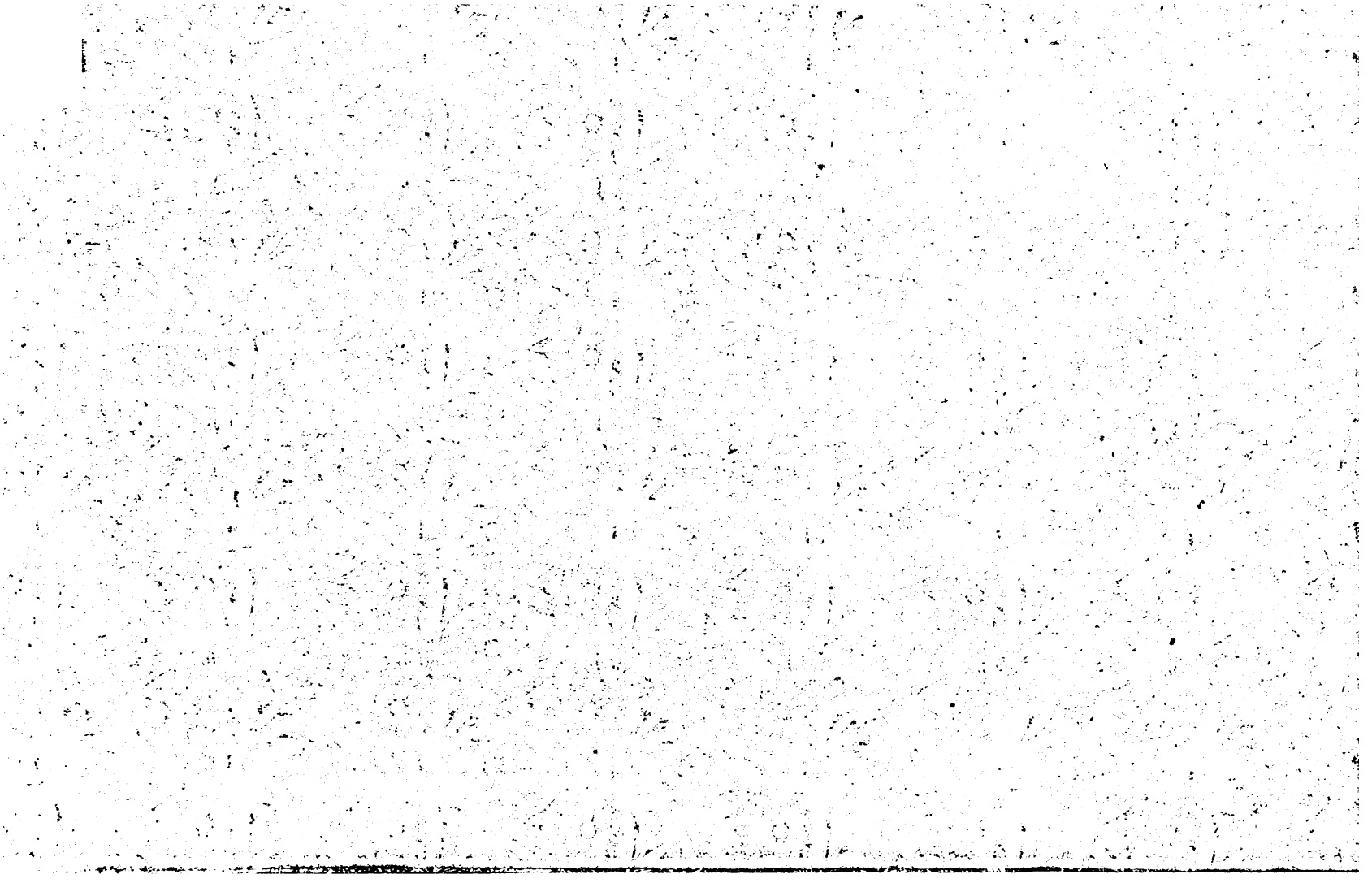
Through the agency of steam we were able to develop electricity, and through one of the channels of electricity, the telegraph, we were able to develop the knowledge of meteorology, or gain a knowledge of our atmosphere quite surprising to us and beyond anything ever before conceived of. For us to have this knowledge of the atmosphere of our globe would seem to be not only very satisfactory to us from a scientific standpoint, but highly satisfactory from a practical point of view.

The telegraph system made it practical for us to understand the mysteries that preside over this department. The telegraph has done this much for meteorology: It has made the weather map a reality. The weather map has made many returns to humanity, but there is one that this great illuminator may even return to electricity. What is electricity, is a question often asked yet never satisfactorily answered. Perhaps the weather map may not be able to satisfy those who seek the impossible, or to proclaim

the *first cause;* still there is no department wherein the mind of man may be led nearer to the *first cause.* In this respect it is the peer of the best channels flowing in this direction. Franklin connected the electricity of the earth with that of the higher atmosphere, sometimes called the heavens. The weather map, if we will but heed it, readily explains to us the nature of this heavenly electricity and the factors and conditions which go to form it, and which every time will produce it; and all that is necessary is the grand factor, heat from the sun and a little suspended moisture, as when the atmosphere is in the condition as represented by Plate III, a condition that prevails in the warmer months of the year, but not impossible even in midwinter, an abundance of north "LOW," with a moderate "HIGH" in the south. By this combination and juxtaposition of "HIGH" and "LOW" the warm south winds will be carried far to the north, and here the clouds will be massed and the suspended moisture thereof enveloped in heat; on the under side by the warm airs from the south, the while superheated by the heated lands over which they are passing; on the upper side by the direct rays of the sun. The only factors present are the air, the water, and the heat; these, in such a combination as illustrated by Plate III, produce what is termed electricity. Here we have all that is required to form electricity, which, when let free, escapes to the earth, the great storehouse of many wonderful agents which go to make up this wonderful world of ours.

ISAAC P. NOYES.

WASHINGTON, D. C.,
March, 1892.



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